Effect of fine aggregate replacement by granulated blast furnace slag on the self - cured geopolymer concrete

A Research Proposal

by

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1. Introduction

Emission of green-house gases from the cement industries is one of the major causes of global warming and ozone layer depletion so also the production of huge amount of agricultural and industrial by-products such as Granulated Blast Furnace Slag (GBFS), fly ash, Palm Oil Fuel Ash (POFA), red mud, metakaolin and Rice Husk Ash (RHA) affect the environment. To overcome the environmental degradation by above mentioned factors it has drawn the attention of the researchers to use these wastes and by products as one of the constituents of concrete with replacement of conventional ingredients of concrete with special focus on replacement of fine aggregates.

J. Devidovits [1] has introduced the concept of synthesis of geopolymer with aggregates and aluminosilicate materials such as fly ash, RHA, POFA, ground granulated blast furnace slag (GGBFS) and metakaolin. It is found that these additives provide powerful alkali solution of potassium/sodium silicate and hydroxide which result into energized. Turner and Collins [2] have reported that the emission of $CO_2$from geopolymer concrete was to the tune of 9% which is very small compared to the emission of CO2 from normal concrete. A. Islam et al. [3] have found that the inclusion oil palm shell as a coarse aggregate in geopolymer concrete has reduced the carbon footprint by 50–60% as compared to the OPC based concrete. C. Ng et al. [4] have observed that the production of geopolymer reduces the power consumption by 15% and greenhouse gas emission by 44–64%. A. Mehta et al. [5] and M.Olivia et al.[6] have noted that alkali-activated geopolymer concrete showed good workability and abrasion resistance, low drying shrinkage, high initial strength and excellent bonding strength between reinforcing steel bar and geopolymer concrete as compared to normal concrete. M. Albitar et al. [7] have showed that normal concrete is less durable than the geopolymer concrete due to acidic exposure.

2. Objectives of the research work:

This research is aimed at:

1) To work out the optimal doses of fly ash, sodium hydroxide and sodium silicate in concrete mixture as it render compressive strength and workability to the self-cured geopolymer concrete.

2) To investigate the effect of the replacement of fine aggregate by GBFS on workability, and strength parameters.

3) To study the effect of GBFS as the fine aggregate on durability of the self-cured geopolymer concrete.

3. Literature Review:

D. Hardjito et al. [8] concluded that the optimum range of curing time and temperature was 6 to 96 hours and 30–90^{0}C, respectively. From the workability test, it was suggested that geopolymer concrete can be used up to 120 min.

A. Mehta and R. Siddique [9]observed from the research that workability and permeability decrease with the increment in the percentage of OPC but mechanical properties of the geopolymer concrete improves up to the 20% replacement. It was also concluded that due to inclusion of the calcium (as OPC) formed C–S–H gel in addition to the CASH and NASH gel, so early age strength of geopolymer concrete also improves.

T. Phoo-ngernkham et al.[10] showed that properties of geopolymer pastes were mainly depends on the source material and activators. Results also indicate that C–S–H gel were formed in the NH and NHNS activated and GGBFS based geopolymer paste. The compressive strength, shear bond strength and microstructure of geopolymer paste were improved due to the formation of C–S–H gel.

A. Mehta and R. Siddique [11] reported that compressive strength had improved with the increase in OPC percentage, while the same behavior did not seen during the resistance of sulfuric acid. The optimum replacement percentage of OPC is 10%, were also reported.

C.D. Atis et al. [12]indicated that it is possible to obtain a very high compressive strength 120 MPa and flexural tensile strength 15 MPa from fly ash geopolymer mortar mixture activated with 14% NaOH, and cured at 115 ^{0}C for 24 h.

A.A. Aliabdo et al. [13] stated that with increment of water quantity enhanced the workability, while, reverse effect were found on the other properties of fly ash based geopolymer concrete

and up to 30 kg/m^3 water addition showed best results. Results showed that 16 M, 0.4 and 10.5 kg/m^3 was the optimum values of molarity, ratio of NaOH to Na_2SiO_3 and superplasticizer dose, respectively, for acceptable results.

4. Methodology of the research work:

The outline of research work is as follows:-

1. Initial testing of all raw materials will be completed according to the Indian Standards.
2. Optimum proportion of all ingredients of Geopolymer Concrete will be determined by using Taguchi's method.
3. Effect of replacement of fine aggregates by GBFS in progressive proportions 0, 20, 40, 60, 80 and 100% will be analyzed on workability, strength parameters viz. compressive, split tensile and flexural strength and durability of geopolymer concrete.

5. Expected Outcomes:

1. The compressive strength and workability of self-cured geopolymer concrete will be maximum for the optimal doses of fly ash, sodium hydroxide and sodium silicate in concrete mixture.
2. The new construction material i.e. geopolymer concrete with GBFS might have an added advantage of enhanced workability and strength with no requirement of heat/water curing.
3. GBFS as an alternative to fine aggregates of the self-cured geopolymer concrete may provide better durability i.e. loss in weight and strength.

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